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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/820,654	04/08/2004	Mark S. Haberbusch	35494US1	8021

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EXAMINER	
PETTITT, JOHN F	
ART UNIT	**PAPER NUMBER**
3744	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

E57

Office Action Summary	Application No.	Applicant(s)	
	10/820,654	HABERBUSCH ET AL.	
	Examiner	Art Unit	
	John Pettitt	3744	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 05 March 2007.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-48 and 50-53 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) 46-48,50,51 and 53 is/are allowed.

6)☒ Claim(s) 1-11,23-27,32,39-45 and 52 is/are rejected.

7)☒ Claim(s) 12-22, 28-31, and 33-38 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

The applicant elected species A (claims 1-48 and 50-53) without traverse in the reply filed on 09/05/2006. The examiner disagrees with the suggestion by the applicant that claim 49 was incorrectly withdrawn, as the applicant clearly elected species A in the response to the restriction/election requirement dated 08/02/2006. The applicant further stated that "claims 1-48 and 50-53 all read on this elected species". As such the restriction requirement is still deemed proper and is therefore made FINAL.

Response to Arguments

Applicant's arguments, see page 15-16, filed 03/05/2007, with respect to the rejection(s) of claim(s) 1 and 2 under 35 U.S.C. § 103 as being unpatentable over Garnier in view of Wang have been fully considered and are persuasive. It is agreed that one of ordinary skill in the art would not be motivated to alter Garnier by adding an orifice pulse tube refrigerator as the system is designed to be isolated mechanically and operated in a laboratory where liquid cryogens would be readily available. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Saho et al. (US 6,332,324), Stautner (US 6,192,690), Laskaris et al. (US 6,438,969) and Inoue et al. (US 5,966,944).

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any

person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 9-10 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The applicant has specifically amended claim 1 to exclude the species shown in Fig. 5 for which the subject matter of claims 9 and 10 are taught (a thermal body projecting into the hydrogen storage vessel and thermally coupled to said orifice pulse tube refrigerator). Therefore, claims 9-10 are inconsistent with the originally filed specification and drawings and represent new matter.

Claim Rejections - 35 USC § 102

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1, 3-10, 23-24, 39-41, and 43 are rejected under 35 U.S.C. 102(b) as being anticipated by Saho et al. (US 6,332,324) hereafter Saho.

In regard to claim 1, Saho teaches a system capable of storing and delivering hydrogen comprising a liquid hydrogen storage vessel (37), a substantially vertically oriented orifice pulse tube refrigerator (Fig. 2; 7; column 20, line 25-67), and a cooling system (thermal shields 13a and 13b and associated thermal isolation members - 40, 41, 12a, 12b) coupled to the orifice pulse tube refrigerator (7), said cooling system (13a, 13b) being adapted to

counteract or abate heat transfer to the storage vessel from the ambient environment (column 3, line 25-35, 55-60; column 11, lines 40-49) and wherein no cold heat exchanger (16) of said orifice pulse tube refrigerator penetrates the liquid hydrogen storage vessel (Fig. 2 and10).

In regard to claim 3, Saho teaches that the cooling system comprises a first thermal jacket (13b) exterior to and substantially enclosing said storage vessel, and a second thermal jacket (13a) exterior to and substantially enclosing said first thermal jacket (13b).

In regard to claim 4, Saho teaches that the cooling system further comprising a super insulation material (12a, 12b) disposed around and substantially enclosing at least said storage vessel (37) and said first thermal jacket (13b).

In regard to claim 5, Saho teaches that the orifice pulse tube refrigerator comprises a first stage orifice pulse tube refrigeration unit (portion of 7 immediately above 24) and a second stage orifice pulse tube refrigeration unit (portion of 7 immediately above 16) that operates at a lower temperature than the first stage refrigeration unit (24; inherent to multiple staged cryocooler refrigerators such as the two stage pulse tube refrigerator disclosed; column 10, lines 57-65), said first stage refrigeration unit (24) being thermally coupled to said second thermal jacket (13a), and said second stage refrigeration unit (16) being thermally coupled to said first thermal jacket (13b).

In regard to claim 6, Saho teaches that the first stage refrigeration unit (portion of 7 immediately above 24) comprising a first stage cold heat exchanger

(inherent to two stage pulse tube refrigerator - part of cooling stage 24) having a first refrigerant fluid flow passage (inherent to cooling stage 24) that is coupled to and in fluid communication with said second thermal jacket (13a), said second stage refrigeration unit (portion of 7 immediately above 16) comprising a second stage cold heat exchanger (inherent to two stage pulse tube refrigerator - part of cooling stage 16) having a second refrigerant fluid flow passage (inherent to cooling stage 16) that is coupled to and in fluid communication with said first thermal jacket (13b), wherein a first refrigerant fluid (helium at first stage temperature; column 10, line 5), refrigerated at said first stage cold heat exchanger to a first temperature (capable of 50 K - column 5, line 62), is circulated through said second thermal jacket (13a) during operation of said system, and wherein a second refrigerant fluid (helium at first stage temperature; column 10, line 5), refrigerated at said second stage cold heat exchanger to a second temperature (capable of 7 K - column 5, line 62), is circulated through said first thermal jacket (13b) during operation of said system.

In regard to claim 7, Saho teaches that the system is capable of operating with the first temperature of 60-100K.

In regard to claim 8, Saho teaches that the system is capable of operating at the second temperature of 13-20K.

In regard to claim 9, Saho teaches that said cooling system comprises a heat transfer body (29) projecting directly into a hydrogen storage volume of said storage vessel (37; from cooling plate 41), said heat transfer body (29) being thermally coupled to said orifice pulse tube refrigerator (through cooling plate 41).

In regard to claim 10, Saho teaches that the heat transfer body comprises a heat transfer fin (29).

In regard to claim 23, Saho teaches an outer housing (6) defining a primary vacuum chamber therein (38), said liquid hydrogen storage vessel (37) and said cooling system (thermal shields 13a and 13b and associated thermal isolation members - 40, 41, 12a, 12b) being disposed within said primary vacuum chamber.

In regard to claim 24, Saho teaches that the operative cold components of said orifice pulse tube refrigeration unit (7) are disposed within said primary vacuum chamber (6).

In regard to claim 39, Saho teaches that the system is capable of maintaining liquid hydrogen in said storage vessel (37) at or below 20K at steady state, such that substantially no venting of vaporized hydrogen is necessary to relieve hydrogen overpressure within the vessel (37; column 3, lines 1-14, 33-35; column 19, line 56).

In regard to claim 40, Saho teaches an oscillatory gas pressure power source (20) coupled to said orifice pulse tube refrigerator (7), said oscillatory gas pressure power source (20) being adapted to provide periodic pressure surges in a working fluid to drive said orifice pulse tube refrigerator to thereby generate refrigeration power (inherent to orifice pulse tube refrigerators).

In regard to claim 41, Saho teaches that the oscillatory gas pressure power source being an electric gas compressor (column 6, lines 17-21).

In regard to claim 43, Saho teaches that the orifice pulse tube

refrigerator comprising a first stage orifice pulse tube refrigeration unit (portion of 7 immediately above 24) and a second stage orifice pulse tube refrigeration unit (portion of 7 immediately above 16), each of the first and second stage refrigeration units (inherently) comprise a respective regenerator, cold heat exchanger, pulse tube and hot heat exchanger, wherein net refrigeration power for each of the first and second stage refrigeration units is generated respectively at the first stage cold heat exchanger and the second stage cold heat exchanger.

Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by Stautner (US 6,192,690) hereafter Stautner. Stautner teaches a system capable of storing and delivering hydrogen comprising a liquid hydrogen storage vessel (16; column 1, lines 17-27), a substantially vertically oriented orifice pulse tube refrigerator (32), and a cooling system (radiation shields) coupled to the orifice pulse tube refrigerator (32), said cooling system (radiation shields) being adapted to counteract or abate heat transfer to the storage vessel (16; column 1, lines 17-27) from the ambient environment and wherein no cold heat exchanger of said orifice pulse tube refrigerator (32) penetrates the liquid hydrogen storage vessel (16).

Claim 1 is rejected under 35 U.S.C. 102(b) as being anticipated by Inoue et al. (US 5,966,944) hereafter Inoue. Inoue teaches a system capable of storing and delivering hydrogen comprising a liquid hydrogen storage vessel (3), a substantially vertically oriented orifice pulse tube refrigerator (7), and a cooling

system (liquid nitrogen-5 and vacuum vessel -1) coupled to the orifice pulse tube refrigerator (7), said cooling system (liquid nitrogen-5 and vacuum vessel -1) being adapted to counteract or abate heat transfer to the storage vessel (3) from the ambient environment and wherein no cold heat exchanger of said orifice pulse tube refrigerator (7) penetrates the liquid hydrogen storage vessel refrigerator (Figure 3) penetrates the liquid hydrogen storage vessel (3).

Claim 1-2, 23-24, and 26 are rejected under 35 U.S.C. 102(b) as being anticipated by Laskaris et al. (US 6,438,969) hereafter Laskaris.

In regard to claim 1, Laskaris teaches a system capable of storing and delivering hydrogen comprising a liquid hydrogen storage vessel (38), a substantially vertically oriented orifice pulse tube refrigerator (72), and a cooling system (66, 70, 62, 60) coupled to the orifice pulse tube refrigerator (72), said cooling system (66, 70, 62, 60) being adapted to counteract or abate heat transfer to the storage vessel (38) from the ambient environment and wherein no cold heat exchanger of said orifice pulse tube refrigerator (72) penetrates the liquid hydrogen storage vessel (see Fig. 3).

Alternatively, Laskaris teaches a system capable of storing and delivering hydrogen comprising a liquid hydrogen storage vessel (60), a substantially vertically oriented orifice pulse tube refrigerator (72), and a cooling system (66, 70, 62) coupled to the orifice pulse tube refrigerator (72), said cooling system (66, 70, 62) being adapted to counteract or abate heat transfer to the storage vessel (60) from the ambient environment and wherein no cold heat exchanger of

said orifice pulse tube refrigerator (72) penetrates the liquid hydrogen storage vessel (see Fig. 3).

In regard to claim 2, Laskaris teaches a system capable of storing and delivering hydrogen comprising a liquid hydrogen storage vessel (38; Figure 2) in the shape of a hollow toroid (Fig. 2) having an interior surface (interior of tubing 38) that defines a hydrogen storage volume of the storage vessel, a substantially vertically oriented orifice pulse tube refrigerator (72), and a cooling system (60, 70, 66, 52,56, 64, 62, 10) coupled to the orifice pulse tube refrigerator (72), said cooling system being adapted to counteract or abate heat transfer to the storage vessel (which is within 10) from the ambient environment.

In regard to claim 23, Laskaris teaches an outer housing (56) defining a primary vacuum chamber therein (column 4, lines 52; column 6, lines 29-42), said liquid hydrogen storage vessel (60) and said cooling system (66, 70, 62) being disposed within said primary vacuum chamber (within 56).

In regard to claim 24, Laskaris teaches that the operative cold components of said orifice pulse tube refrigeration unit (72) are disposed within said primary vacuum chamber (within 56).

In regard to claim 26, Laskaris teaches that said housing (56) further defining a secondary chamber (lower side portion of 56 is part of further defining secondary chamber 16 within 10; column 3, lines 41-42), separate and apart from said primary vacuum chamber (within 56), said system further comprising relatively high temperature hydrogen conditioning equipment (coil-36, tubing 38;

capable of conditioning hydrogen to increase the hydrogen's temperature) disposed within said secondary chamber (16).

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim 44 is rejected under 35 U.S.C. 103(a) as being unpatentable over the obvious modification of Saho. Saho teaches that the two stage orifice pulse tube refrigerator is capable of being operated at steady state with said first stage cold heat exchanger operating at 60-100K and said second stage cold heat exchanger operating at 13-20K. Saho does not teach what refrigeration power is provided for the various temperature ranges that the first and second stages are capable of operating at; however, Saho is designed to provide cooling to a variety of superconducting electronics. Depending on the size of the electronics the orifice pulse tube refrigerator would necessarily be designed or selected to meet the required heat load from the electronics (and any remaining heat leak from the environment). One of ordinary skill in the art would know how to appropriately design and select a two-stage pulse tube refrigerator that would be capable of supplying 4-6 Watts of refrigeration at the superconducting temperatures of interest and would be motivated to do so in order to efficiently maintain the cryogenic temperature of the electronics. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to employ a two-stage orifice pulse tube refrigerator that is capable of

providing 4-6 Watts of refrigeration at the temperatures desired for the purpose of maintaining proper operation of the superconducting electronics.

Claims 11 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Saho in view of C. Wang et al. (Cryogenics, 1997, Vol. 37, Issue 12, p. 857-863) and Wang (US 6,378,312).

In regard to claim 11, Saho teaches all of the limitations of claim 1 and further discloses an oscillatory gas pressure power source (20; inherent to orifice pulse tube refrigerators) coupled to said orifice pulse tube refrigerator (7) via a transfer tube (23b), said orifice pulse tube refrigerator comprising a first stage orifice pulse tube refrigeration unit (portion of 7 immediately above 24) and a second stage orifice pulse tube refrigeration unit (portion of 7 immediately above 16), but Saho does not explicitly teach the specific components of the two stage orifice pulse tube refrigerator (7).

However, Wang et al. (p.857) teach a high performing two-stage orifice pulse tube refrigerator (Figure 1(d)) capable of operating at the temperatures of the Saho system. Wang et al. (p.857) teach that each of the first and second stage (Figure 1(d)) refrigeration units comprise a respective regenerator (12 and 13), cold heat exchanger (17 and 20), pulse tube (16 and 19), hot heat exchanger (15 and 18), primary orifice (5 and 7), inertance tube (8 and 11) and reservoir volume (9 and 10), and each stage having a second orifice (4 and 6 or alternatively 5 and 7 can act as primary and secondary valves) connecting the respective hot heat exchanger to the transfer tube (line extending from 2).

Further, Wang (p.857) teaches that his disclosed two-stage orifice pulse tube refrigerator is highly efficient, has high reliablility, and low vibrations and production cost (page 857, column 2). Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to employ the two stage orifice pulse tube refrigerator of Wang (p.857) in the cryostat of Saho for the purpose of providing an efficient, reliable, low cost refrigerator for system.

In regard to claim 32, Saho teaches all of the limitations of claim 1 and further disclose a first stage orifice pulse tube refrigeration unit (portion of 7 immediately above 24) and a second stage orifice pulse tube refrigeration unit (portion of 7 immediately above 16) that operates at a lower temperature than the first stage refrigeration unit (inherent to staged orifice pulse tube refrigerators), but Saho does not explicitly teach the specific components of the two stage orifice pulse tube refrigerator (7).

However, Wang et al. (p.857) teach a high performing two-stage orifice pulse tube refrigerator (Figure 1(d)) capable of operating at the temperatures of the Saho system. Wang et al. (p.857) teach that each of the first and second stage (Figure 1(d)) refrigeration units comprise a respective regenerator (12 and 13), cold heat exchanger (17 and 20), pulse tube (16 and 19), hot heat exchanger (15 and 18), said second stage regenerator (13) having a second heat absorptive material therein (regenerator is layered with three layers, lead meets the criteria below), said second heat absorptive material having a volumetric heat capacity of at least 0.23 J/cm3K at 13-14K, a volumetric heat capacity of at least 0.5 J/cm3K at 18-20K (support that this information is implicit, see "Numerical

analysis of 4K pulse tube coolers: Part I. Numerical Simulation", Cryogenics, C. Wang, 1997, Vol. 37, issue 4, Figure 3), and a porosity of 0.2-0.5 (implicitly taught; proven by porosity taught in C. Wang, Vol. 37, issue 4, p.211, 2nd paragraph).

Further, Wang (p.857) teaches that his disclosed two-stage orifice pulse tube refrigerator is highly efficient, has high reliablility, and low vibrations and production cost (page 857, column 2). Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to employ the two stage orifice pulse tube refrigerator of Wang (p.857) in the cryostat of Saho for the purpose of providing an efficient, reliable, low cost refrigerator for system.

Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saho in view of Rampersad et al. (US 6,640,552) hereafter Rampersad. Saho teaches all of the limitations of claim 24 but does not disclose what pressure the vacuum of the primary chamber is maintained at. However, it is well known in the art that vacuum insulation is maintained at less than 10^{-4} Torr as taught be Rampersad (column 2, line 50) for the purpose of providing thermal insulation. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to employ a vacuum of less than 10^{-2} Torr for the purpose of insulating the components within the primary chamber from ambient heat leak.

Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Laskaris in view of Rampersad. Laskaris teaches all of the limitations of claim 24 but does

not disclose what pressure the vacuum of the primary chamber is maintained at. However, it is well known in the art that vacuum insulation is maintained at less than 10^{-4} Torr as taught be Rampersad (column 2, line 50) for the purpose of providing thermal insulation. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to employ a vacuum of less than 10^{-2} Torr for the purpose of insulating the components within the primary chamber from ambient heat leak.

Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Laskaris in view of Rampersad. Laskaris teaches all the limitations of claim 26 but does not disclose what pressure the vacuum of the secondary chamber is maintained at. However, it is well known in the art that vacuum insulation is maintained at less than 10^{-2} Torr as taught be Rampersad (column 2, line 50) for the purpose of providing thermal insulation. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to employ a vacuum of less than 10^{-2} Torr for the purpose of insulating the components within the secondary chamber from ambient heat leak.

Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saho in view of Foster et al. ("Development of a High Capacity Two-Stage Pulse Tube Cryocooler", Cryocoolers 12, March 1, 2003, p.225-232). Saho does not explicitly teach that the compressor employed for the pulse tube refrigerator has a linear drive and flexure bearings. However, Foster teaches a linear drive

flexure bearing compressor (p. 232, paragraph 2, p. 225 - abstract and introduction) are robust, provide good reliability, and low vibrations with an overall low mass. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to modify the refrigerator of Saho with the linear drive flexure bearing compressor of Foster to improve the reliability and lower the mass of the overall system.

Claim 45 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gene D. Berry et al. ("Hydrogen Storage and Transportation", U.S. Department of Energy, doc. No. UCRL-JC-149882, July 24, 2003, pages 1-38) hereafter Berry in view of Saho. Berry teaches an automobile comprising a hydrogen-powered internal combustion engine but does not teach a hydrogen storage and delivery system according to claim 1. However Berry suggests employing active refrigeration (p. 12, paragraph 2) and teaches that liquid hydrogen vehicles would be favorably efficient if the ambient heat leak in to the storage vessel could be reduced (page 13 - end of section). Saho teaches a cryostat capable of significantly reducing boil off of stored cryogen via active refrigeration in the form of a two stage orifice pulse tube refrigerator as claimed in claim 1. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to combine the cryostat system of Saho in the liquid Hydrogen (LH2) powered automobile taught by Berry to provide a LH2 vehcile with superior cryogen retention capability as taught by both Berry (page 12) and Saho (column 3, lines 1-14, 33-35; column 19, line 56).

Claim 52 is rejected under 35 U.S.C. 103(a) as being unpatentable over Saho in view of Haberbusch et al. (US 6,431,750) hereafter Haberbusch. Saho teaches all the limitations of claim 1 but does not explicitly teach a liquid level probe comprising adhered flexible dielectric strips and a series of temperature sensor disposed at spaced intervals along the length of the probe. However, it is common in the art to employ a liquid level sensor within cryogen storage volumes for the purpose of determining the amount of cryogen with the storage volume. In addition, Haberbusch teaches a liquid level probe (20) comprising adhered flexible dielectric strips (40) and a series of temperature sensors (22) disposed at spaced intervals along the length of the probe (20) useful for determining the level of cryogenic liquid within a storage volume. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to modify the system of Laskaris by installing the liquid level sensor of Haberbusch within the storage vessel (37) for the purpose of providing a convenient means of determining the liquid level of the storage vessel (37).

Claim 52 is rejected under 35 U.S.C. 103(a) as being unpatentable over Laskaris in view of Haberbusch. Laskaris teaches all the limitations of claim 1 but does not explicitly teach a liquid level probe comprising adhered flexible dielectric strips and a series of temperature sensor disposed at spaced intervals along the length of the probe. However, it is common in the art to employ a liquid level sensor within cryogen storage volumes for the purpose of determining the

amount of cryogen with the storage volume. Haberbusch teaches a liquid level probe (20) comprising adhered flexible dielectric strips (40) and a series of temperature sensors (22) disposed at spaced intervals along the length of the probe (20) useful for determining the level of cryogenic liquid within a storage volume. Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to modify the system of Laskaris by installing the liquid level sensor of Haberbusch within the storage vessel (60) for the purpose of providing a convenient means of determining the liquid level of the storage vessel.

Allowable Subject Matter

Claims 46-48, 50-51, and 53 are allowed.

Claims 12-22, 28-31, and 33-38 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Dinulescu et al. (4,292,062) teaches a cryogenic fuel storage and delivery system which employs a cryogenic expansion refrigeration system to insulate the cryogenic fuel from ambient heat leak to reduce or negate venting.

Prior art that teaches that vacuum insulation is commonly less than 10^{-4} or 10^{-5} Torr:

Matsch (US 3,007,596)

Moore (US 3,262,279)

Hawkins et al. (US 3,358,463)

Hofmann (US 3,930,375)

Prior art that teaches that it is common in the art to employ a liquid level sensor within cryogen storage volumes for determining liquid levels:

Mooney (US 4,362,403)

Janotta (US 4,915,507)

Hasselman (US 4,672,842)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Pettitt whose telephone number is 571-272-0771. The examiner can normally be reached on M-F 8a-4p.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Cheryl Tyler can be reached on 571-272-4834. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service

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/John Pettitt/
Examiner
Art Unit 3744

JFP III
May 24, 2007

Cheryl J. Tyler
CHERYL TYLER
SUPERVISORY PATENT EXAMINER